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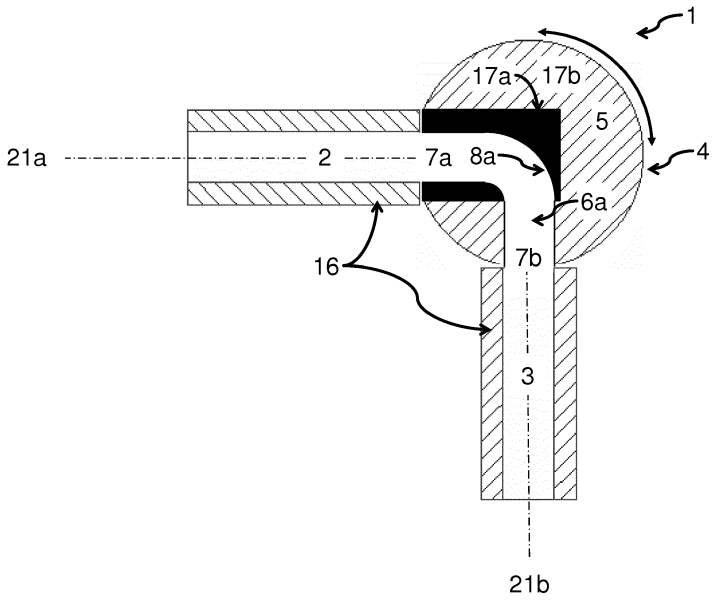
(54) **FLOW CHANNEL WITH AN ARCUATE SEGMENT**

(57) Flow channel with an arcuate segment. A valve (1) comprising: a valve body having an inlet (2), an outlet (3); the valve (1) further comprising a valve member (4) situated in the fluid path between the inlet (2) and the outlet (3); wherein the valve member (4) comprises a solid portion (5), a first (7a) and a second port (7b) and a flow portion (6a; 6b) extending between the ports (7a, 7b); wherein the valve (1) comprises a valve stem (9) defining a pivot axis (10); wherein the flow portion (6a; 6b) has a profile perpendicular to the pivot axis (10); wherein the profile of the fluid flow portion (6) comprises an arcuate segment (8a; 8b), the arcuate segment (8a; 8b) having a side facing the flow portion (6a; 6b) and another side facing the solid portion (5); the arcuate segment (8a; 8b) being perpendicular to the pivot axis (10).

FIG 1



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Description

Background

[0001] The present disclosure relates to a valve and to flow profiles inside the valve. More specifically, the present disclosure focuses on a valve member of a ball valve. The valve member is optimized to exhibit minimum flow resistance.

[0002] Fluid circuits such as circuits for heating, ventilation and/or air-conditioning frequently make use of ball valves. In these valves, a pivoting ball is arranged in between an inlet port and an outlet port. The ball can be selectively pivoted to connect a fluid channel perforating the ball to the inlet and also to the outlet. The valve then is in its open position and enables fluid flow from the inlet to the outlet. The ball can also be selectively pivoted to disconnect the fluid channel from at least one of the inlet or the outlet. The valve is then in its closed position and the fluid path between the inlet and the outlet is obturated.

[0003] The fluid channel perforating the valve member commonly comprises at least two leg portions. A first leg portion may connect to the inlet and a second leg portion may connect to the outlet. The leg portions are typically positioned perpendicular to each other. If a fluid flows through the flow channel, the flow direction of the fluid will change abruptly at the junction between the two leg portions. That abrupt change in direction may impair flow resistance. That is, a pump pushing a fluid through the channel needs to overcome the additional flow resistance due to the change in direction at the junction.

[0004] Flow sensors such as mass flow sensors or volume flow sensors may be arranged in the flow channel through the valve member. These sensors generally record a measure that relates to fluid flow. In order for such sensors to yield accurate measurements, any adverse influence due to turbulence needs be minimized. An abrupt change in direction may actually result in turbulent flow. It follows that abrupt changes in flow direction should be avoided in order for flow sensors to deliver accurate readings.

[0005] The Chinese utility model CN205689801U was filed on 21 June 2016 and issued on 16 November 2016. CN205689801U discloses a valve member 2 with a curved flow channel 9. The valve member 2 is pivotal about an axis defined by a valve stem 3. It sits inside a housing 1 and is disposed inside a fluid path 10. The fluid path 10 can be selectively opened by pivoting member 2 in its open position. The fluid path can also be selectively closed by pivoting the valve member 2 in its closed position.

[0006] The flow channel 9 perforating valve member 2 has an arcuate profile thereby avoiding an abrupt change in direction. The flow channel 9 has a profile along a plane defined by the fluid paths 9, 10. That profile provides a wall segment on the outside of the bent. This wall segment points in the direction of the valve stem 3. The profile also provides a wall segment on the inside of the bent. The latter wall segment points away from the valve stem 3. The valve member comprises both the wall segment on the inside of the bent and the wall segment on the outside of the bent.

[0007] A European patent application EP2708783A1 was filed on 24 June 2013. The patent application was published on 19 March 2014. EP2708783A1 teaches a valve for opening and closing a conduit through a wall of a submarine. The valve of EP2708783A1 comprises a fluid flow portion 46 with an arcuate segment 48. The fluid flow portion 46 is pivotal about an axis X. The fluid flow portion 46 is formed as a recess in a solid portion 40. The valve member of EP2708783A1 comprises no cylindrical portions.

[0008] A pivotal movement of valve stem 3 induces the same pivotal movement of valve member 2. If the valve 1 is initially in its open position and valve stem 3 is pivoted by 180°, the valve 1 may again end up in an open position. That is, the flow channel 9 exhibits rotational symmetry under 180° pivotal movements of the valve stem 3.

The instant disclosure improves on valve members of ball valves. Valves according to the instant disclosure mitigate the aforementioned shortcomings of flow paths with two perpendicular legs.

Summary

[0009] The present disclosure aims at providing a valve member for a ball valve that inhibits turbulence. To that end, abrupt changes in the direction of fluid flow are avoided. Accordingly, a valve member with a fluid flow portion is provided that meets these requirements. Also, an accidental pivotal movement of the valve member by 180° shall not move the valve member from an open position to another open position. That is, no 180° turn of the valve member due to personnel error shall fail to close an initially open fluid path.

[0010] The instant disclosure thus teaches a valve, the valve comprising: a valve body having an inlet conduit, an outlet conduit, and a fluid path extending between the inlet conduit and the outlet conduit; the valve further comprising a valve member situated in the fluid path between the inlet conduit and the outlet conduit; wherein the valve member comprises a solid portion and a first port and a second port and a fluid flow portion extending between the first port and the second port; wherein the valve comprises a valve stem anchored to the solid portion of the valve member, the valve stem defining a pivot axis; wherein the valve stem is configured to selectively pivot the valve member about the pivot axis defined by the valve stem to a closed position which closes the fluid path between the inlet conduit and the outlet conduit and to an open position which opens the fluid path between the inlet conduit and the outlet conduit; wherein the fluid flow portion has a profile in a plane perpendicular to the pivot axis; wherein the profile of the fluid flow portion comprises an arcuate segment; wherein the inlet conduit defines an inlet flow axis of fluid flow directly into the fluid

flow portion and the outlet conduit defines an outlet flow axis of fluid flow directly from the fluid flow portion; and and wherein the pivot axis is perpendicular to at least one of the inlet flow axis or the outlet flow axis.

[0011] According to an aspect, the inlet conduit defines an inlet flow axis and the outlet conduit defines an outlet flow axis; and the pivot axis is perpendicular to both the inlet flow axis and the outlet flow axis.

[0012] Advantageously, a pivotal movement of the valve member by 180° about the pivot axis and starting at the open position closes and/or obturates the fluid path.

[0013] It is also an object of the instant disclosure to provide a valve member with a fluid flow portion that is suitable for production by milling. The valve member can thus be produced using standard tools. The fluid flow portion advantageously is a recess that can be removed from the solid portion of the valve member by milling.

[0014] It is another object of the instant disclosure to provide a valve member with a fluid flow portion that is, completely or at least in part, suitable for production by drilling. The valve member can thus be produced using standard tools. The fluid flow portion advantageously comprises a cylindrical conduit or a bore that can, completely or at least in part, be drilled into the solid portion of the valve member.

[0015] It is another object of the instant disclosure to provide a valve member that is compatible with a large number of conventional valves. A ball-type valve member is such a valve member.

[0016] It is still an object of the instant disclosure to minimize mechanical forces applied by fluid flow through the fluid flow portion on the valve member. To that end, the arcuate segment is disposed at or near the centre of the valve member. Also, the arcuate segment advantageously exhibits reflection symmetry about axis through the centre of the valve member.

[0017] It is a further object of the instant disclosure to minimize vibrations caused by fluid flow through the fluid flow portion. To that end, a bent knee conduit comprising the arcuate segment is disposed at or near the centre of the fluid flow portion.

[0018] It is also an object of the instant disclosure to minimize turbulence caused by fluid flow through the fluid flow portion. To that end, the radius of curvature of the knee conduit is at least 1 mm, preferably at least 2 mm or even at least 5 mm. It is also envisaged that the radius of curvature of the knee conduit is at least one tenth of a diameter of a ball-type valve member, preferably at least one fifth of the diameter of a ball-type valve member or even at least half the diameter of a ball-type valve member.

[0019] It is yet another object of the instant disclosure to provide a valve member that is compatible with canonical quarter-turn valves. To that end, the arcuate segment forms an arc with an arc angle of at least 60°, preferably at least 70° or even at least 80°. In an embodiment, the arc angle is 90°.

[0020] It is yet another object of the instant disclosure to provide a valve that is suitable for use in heating, ventilation, and air-conditioning circuits. Accordingly, a multi-way valve is provided with a valve according to the instant disclosure.

Brief description of the drawings

[0021] Various features will become apparent to those skilled in the art from the following detailed description of the disclosed non-limiting embodiments. The drawings that accompany the detailed description can be briefly described as follows:

FIG 1 is a schematic section view of a valve in its open position according to a first embodiment of the present disclosure.

FIG 2 is another schematic section view in a plane perpendicular to that of FIG 1.

FIG 3 is a close-up detailed view showing the curvature of a fluid flow portion with a bent knee conduit.

FIG 4 is another schematic section view of a valve in its open position according to another embodiment of the present disclosure.

Detailed decription

[0022] The valve of the instant disclosure is typically part of a multi-way valve and/or of a valve assembly. According to one aspect of the instant disclosure, a plurality of the valves is arranged in a single multi-way valve.

[0023] The valve 1 as shown in FIG 1 has an inlet conduit 2 and an outlet conduit 3. One of ordinary skill in the art upon reviewing this disclosure understands that the valve 1 is not limited to a single inlet conduit 2 and not limited to a single outlet conduit 3, and may provide a plurality of inlet conduits and/or a plurality of outlet conduits. A fluid path extends from the inlet conduit 2 to the outlet conduit 3 of the valve 1. The valve as shown on FIG 1 is in an open position as shown in FIG 1. That is, the valve member 4 in the fluid path does not obstruct fluid flow.

[0024] The inlet conduit 2 defines an axis of fluid flow 21a through the inlet conduit 2. According to an aspect of the instant disclosure, the inlet conduit 2 defines an axis of laminar fluid flow 21a through the inlet conduit 2. The outlet conduit 3 defines an axis of fluid flow 21b through the outlet conduit 3. According to an aspect of the instant disclosure, the outlet conduit 3 defines an axis of laminar fluid flow 21b through the outlet conduit 3.

[0025] A valve member 4 is disposed in the fluid path. The valve member 4 depicted on FIG 1 is, by way of non-limiting example, ball-shaped and/or cylindrical and/or elliptical. The valve member 4 also is pivotal, preferably is pivotal about an axis perpendicular to the drawing plane of FIG 1.

[0026] In an embodiment, the valve 1 comprises a valve body 16 that is made of a metallic material such as steel, in particular of austenitic (stainless) steel or of ferrite steel. In an alternate embodiment, the valve body 16 is made of aluminum (alloy) or of brass or of gunmetal. In yet another alternate embodiment, the valve body 16 is made of a polymeric material. According to an aspect, valve body 16 is manufactured via an additive manufacturing technique such as three-dimensional printing. According to a particular aspect, a portion of valve body 16 is manufactured via an additive manufacturing technique such as three-dimensional printing.

[0027] The valve member 4 comprises a solid portion 5 that is advantageously made of a ceramic material. The solid portion 5 is preferably made of engineering ceramics, yet more preferably of aluminum oxide (Al_2O_3) and/or of silicon carbide (SiC) and/or of zirconium dioxide (ZrO_2) and/or of magnesium oxide (MgO). The valve member may be comprised of a ceramics material such as aluminum oxide with a suitable level of purity such as 92%, 96%, or 99%. Higher levels of purity confer advantages in terms of mechanical stiffness and strength and/or dielectric strength.

[0028] In an alternate embodiment, the solid portion 5 of valve member 4 is made of a metallic material such as steel, in particular of austenitic (stainless) steel or of ferrite steel. In an alternate embodiment, the solid portion 5 is made of aluminum (alloy) or of brass or of gunmetal. In yet another alternate embodiment, the solid portion 5 is made of a polymeric material. According to an aspect, an additive manufacturing technique such as three-dimensional printing is employed to fabricate the solid portion 5.

[0029] Inlet conduit 2 and outlet conduit 3 are advantageously cylindrical or substantially cylindrical. That is, inlet conduit 2 and outlet conduit 3 have got circular or substantially circular cross-sections perpendicular to their respective flow axes 21a, 21b. According to an aspect of the disclosed embodiments, at least one of the inlet conduit 2 or the outlet conduit 3 is a bore or a through-hole. It is envisaged that the two conduits 2 and 3 are both bores or are both through-holes. Inlet conduit 2 and/or outlet conduit 3 may, in alternate embodiments, provide elliptical or polygonal cross-sections.

[0030] It is envisaged that inlet conduit 2 has got a minimum cross-section area perpendicular to its flow axis of at least 10 mm^2. The cross-section area more preferably is at least 64 mm^2, yet more preferably at least 100 mm^2. Larger cross-section areas confer advantages in terms of enhanced flow. It is also envisaged that outlet conduit has got a minimum cross-section area perpendicular to its flow axis of at least 10 mm^2. The cross-section area more preferably is at least 64 mm^2, yet more preferably at least 100 mm^2. According to an aspect of the instant disclosure, the minimum cross-section area perpendicular to the flow axis is at least 0.01 times a maximum cross-section of a ball-type valve member, preferably at least 0.05 times the maximum cross-section of a ball-type valve member or even at least 0.1 times the maximum cross-section of a ball-type valve member.

[0031] Inlet conduit 2 and outlet conduit 3 provide same or similar cross-section areas perpendicular to their respective flow axes. The cross-section areas of conduits 2 and 3 advantageously differ by less than 30%, yet more preferred by less than 10%, still more preferred by less than 5%. According to an aspect, conduits 2 and 3 of provide fluid paths of same or of similar lengths and/or length dimensions. The length dimensions of the fluid paths of conduits 2 and 3 advantageously differ by less than 30%, yet more preferred by less than 10%, still more preferred by less than 5%.

[0032] The aspect ratios of inlet conduit 2 and/or of outlet conduit 3 relate the lengths of their respective fluid paths to their minimum diameters perpendicular to their fluid paths. The aspect ratios of inlet conduit 2 and/or of outlet conduit 3 are preferably less than ten, yet more preferably less than five, still more preferably less than two. Smaller aspect values confer advantages in terms of precisely defined flow axes.

[0033] FIG 1 shows valve 1 in its open position. Valve member 4 is oriented so as to enable fluid flow through a fluid flow portion 6a of the valve member 4. In an embodiment, the fluid flow portion 6a is a conduit or a fluid flow channel.

[0034] Inlet conduit 2 provides a supply end for supply of a fluid to the valve 1. Likewise, outlet conduit 3 provides a return end. A fluid such as water and/or a blend thereof, in particular a blend of water and of at least one compound selected from

- calcium chloride,
- ethanol,
- ethylene glycol,
- glycerol,
- magnesium chloride,
- methanol,
- potassium acetate,
- potassium formate,
- propylene glycol, or
- sodium chloride

thus enters the valve 1 via inlet conduit 2, then flows via fluid flow portion 6a and leaves via outlet conduit 3. The fluid entering via inlet conduit 2 and leaving via outlet conduit 3 may as well be a combustible fluid and/or a

- R-401A,
- R-404A,
- R-406A,
- R-407A,
- R-407C,
- R-408A,
- R-409A,
- R-410A,
- R-438A,
- R-500, or

- R-502

refrigerant. The fluid may also be (a blend comprising) ammonia and/or carbon dioxide. The above lists are not exhaustive.

[0035] To that end, inlet conduit 2, outlet conduit 3, and fluid flow portion 6a are in fluid communication when the valve 1 is in its open position. FIG 1 shows a first port 7a of valve member 4 that enables fluid communication between inlet conduit 2 and fluid flow portion 6a. Port 7a is advantageously sealed by a gasket or by an O-ring enveloping around the aperture. According to an aspect, the first port 7a is a first aperture. FIG 1 also shows a second port 7b of valve member 4 that enables fluid communication between fluid flow portion 6a and outlet conduit 3. According to an aspect, the second port 7b is a second aperture. Port 7b is advantageously sealed by a gasket or by an O-ring enveloping around the aperture.

[0036] Now turning to FIG 2, a valve stem 9 for actuation of valve member 4 is shown. The valve stem 9 that is anchored the solid portion 5 of valve member 4 may, by way of non-limiting example, be employed for pivotal movement of valve member 4. A valve stem 9 such as a plunger is then advantageously joined to the solid portion 5 of the valve member 4. That plunger 9 enables pivotal movement of valve member 4 about an axis perpendicular to the drawing plane of FIG 1.

[0037] FIG 2 also illustrates a diameter dimension 11 of valve member 4. In an embodiment, valve member 4 is a ball-type valve member 4. That is, valve member 4 has spherical symmetry or substantially spherical symmetry. The diameter dimension 11 of valve member 4 hence is the largest distance between any two points on the outer envelope of the valve member 4.

[0038] The valve member 4 may also have cylindrical or elliptical symmetry with a pivot axis 10 defined by valve stem 9. The diameter dimension 11 in this case refers to the distance between two points, each point lying on an axis perpendicular to the pivot axis 10. The diameter dimension 11 thus is the largest such dimension between two points on the outer envelope of valve member 4.

[0039] Details of the fluid flow portion 6a are depicted in FIG 3. The fluid flow portion 6a of FIG 3 is an elbow-shaped and/or L-shaped conduit with a first cylindrical conduit 14a and with a second cylindrical conduit 14b. According to an aspect of the disclosed embodiments, cylindrical conduits 14a and 14b are legs of the fluid flow portion 6a of valve member 4. The first cylindrical conduit 14a is in fluid communication with second cylindrical conduit 14b via a bent knee conduit 14c. The knee conduit 14c preferably is a central conduit. Laminar flow, in particular laminar flow in the absence of turbulence, of a fluid through cylindrical conduits 14a, 14b defines an axis for each cylindrical conduit. In an embodiment, laminar flow through the cylindrical conduits 14a, 14b is characterized by a Reynolds number Re < 1200. The (flow) axes of cylindrical portions 14a, 14b are advantageously perpendicular such as in an embodiment wherein the fluid flow portion 6a is an L-shaped conduit. The (flow) axes of cylindrical portions 14a, 14b may also be substantially perpendicular such as in an embodiment where the fluid flow portion 6a is an elbow-shaped conduit.

[0040] The knee conduit 14c is the central portion of fluid flow portion 6a. FIG 3 shows details of conduit 14c. The knee conduit 14c has profile comprising an outer portion. The outer portion is an arcuate segment 8a. The arcuate segment 8a of knee conduit 14c is a segment of a wall of conduit 14c. This wall of conduit 14c separates the fluid flow portion 6a of the valve member 4 from the solid portion 5 of the valve member 4.

[0041] The arcuate segment 8a has a first end. A first axis 12a is perpendicular to the arcuate segment 8a and crosses the arcuate segment 8a at its first end. The arcuate segment 8a also has a second end sitting opposite the first end. A second axis 12b is also perpendicular to the arcuate segment 8a and crosses the arcuate segment 8a at its second end.

[0042] The axes 12a and 12b of arcuate segment 8a advantageously form an arc angle 13 between 120° and 60°, preferably between 110° and 70°, yet more preferably between 100° and 80°. In an embodiment, the arc angle 13 is 90° or substantially 90°. An arc angle 13 of 90° or close to 90° yields a valve member 4 suitable for quarter-turn valves.

[0043] The length of arcuate segment 8a is crucial to the inhibition of turbulence due to an abrupt change in direction of fluid flow. Arcuate segment 8a advantageously has a minimum length thereby inhibiting abrupt changes in flow direction. In an embodiment, the length of arcuate segment 8a is at least 20% of the diameter dimension 11 of valve member 4, preferably at least 30% or even 50% of the diameter dimension 11. According to an aspect, the arcuate segment 8a has a length dimension *l* of at least 2 mm, preferably of at least 5 mm or even 10 mm. It is also envisaged that the arcuate segment 8a has a length dimension *l* that is at least one tenth of the (spherical) diameter 11 of the (ball-type) valve member 4, preferably is at least one fifth of the (spherical) diameter 11 of a (ball-type) valve member 4 or even at least half the (spherical) diameter 11 of the (ball-type) valve member 4.

[0044] The length dimension *l* of arcuate segment 8a is the length of a path s between the first end and the second end of arcuate segment 8a. The length dimension *l* of arcuate segment 8a thus is the curve integral between the first end and the second end along a suitably parametrised path s of segment 8a:

$$l = \int_{\text{first end}}^{\text{second end}} 1 \cdot \mathrm{ds}.$$

[0045] The cross-section of knee conduit 14c also has portion that is a segment 18 on the inside of the bent. Segment 18 on the inside of the bent is closer to the valve body 16 than segment 8a on the outside of the bent.

Segment 18 of knee conduit 14c also is a segment of a wall of knee conduit 14c. This wall of conduit 14c separates the fluid flow portion 6a of the valve member 4 from the solid portion 5 of the valve member 4.

[0046] The segment 18 on the inside of the bent has a first end and a second end sitting opposite the first end. The length dimension *m* of segment 18 on the inside of the bent is the length of a path *p* between the first end and the second end of segment 18. The length dimension *m* of segment 18 on the inside of the bent thus is the curve integral between the first end and the second end along a suitably parametrised path *p* of segment 18:

$$m = \int_{\text{first end}}^{\text{second end}} 1 \cdot \mathrm{dp}.$$

[0047] The length of segment 18 on the inside of the bent generally is less than the length of segment 8a on the outside of the bent. According to an aspect, the segment 18 on the inside of the bent has a length dimension *m* of at least 1 mm, preferably of at least 2 mm or even 5 mm. It is also envisaged that the segment 18 on the inside of the bent has a length dimension of at least one tenth of the (spherical) diameter 11 of the (ball-type) valve member 4, preferably of at least one fifth of the (spherical) diameter 11 of the (ball-type) valve member 4 or even of at least half the (spherical) diameter 11 of the (ball-type) valve member 4.

[0048] It is envisaged that the segment 18 on the inside of the bent has curved shape. It is also envisaged that the segment 18 on the inside of the bent is a straight line connecting its first end to its second end.

[0049] Conduits 14a and 14b are advantageously cylindrical or substantially cylindrical. That is, portions 14a and 14b have got cross-sections perpendicular to their respective flow axes that are circular or substantially circular. Conduits 14a, 14b may, in other embodiments, have cross-sections perpendicular to their respective flow axes that are elliptical or polygonal. According to an aspect, at least one portion 14a, 14b is a bore. It is envisaged that the two portions 14a, 14b are both bores.

[0050] It is envisaged that cylindrical conduit 14a has got a minimum cross-section area perpendicular to its flow axis of at least 10 mm^2. The cross-section area more preferably is at least 64 mm^2, yet more preferably at least 100 mm^2. According to an aspect of the instant disclosure, the cylindrical conduit 14a has got a minimum cross-section area perpendicular to its flow axis of at least 0.01 times a maximum cross-section of the (ball-type valve) member, preferably of at least 0.05 times the maximum cross-section of the (ball-type) valve 4 member or even of at least 0.1 times the maximum cross-section of the (ball-type) valve member 4.

[0051] It is also envisaged that cylindrical conduit 14b has got a minimum cross-section area perpendicular to its flow axis of at least 10 mm^2. The cross-section area more preferably is at least 64 mm^2, yet more preferably at least 100 mm^2. According to an aspect of the instant disclosure, the cylindrical conduit 14b has got a minimum cross-section area perpendicular to its flow axis of at least 0.01 times a maximum cross-section of the (ball-type valve) member, preferably of at least 0.05 times the maximum cross-section of the (ball-type) valve 4 member or even of at least 0.1 times the maximum cross-section of the (ball-type) valve member 4.

[0052] Larger cross-section areas confer advantages in terms of enhanced flow.

[0053] Conduits 14a and 14b have same or similar cross-section areas perpendicular to their respective flow axes. The cross-section areas of conduits 14a and 14b advantageously differ by less than 30%, yet more preferred by less than 10%, still more preferred by less than 5%. According to an aspect, conduits 14a and 14b have fluid paths of same or of similar lengths and/or length dimensions. The length dimensions of the fluid paths of portions 14a and 14b advantageously differ by less than 30%, yet more preferred by less than 10%, still more preferred by less than 5%.

[0054] The aspect ratios of portions 14a and 14b relate the lengths of their respective fluid paths to their minimum diameters perpendicular to their respective flow axes. The aspect ratios of conduits 14a and 14b are preferably less than twenty, yet more preferred less than ten, still more preferred less than five. Smaller aspect values confer advantages in terms of precisely defined flow axes.

[0055] As shown in FIG 1, valve member 4 can be made up of separable portions 17a, 17b. More specifically, the solid portion 5 of valve member 4 provides a port and/or provides a slot. A portion 17a with conduits 14a and 14c can thus be inserted into the slot or port of the portion 17b. According to an aspect, separable portion 17a is mounted inside (a slot of) portion 17b by welding or by gluing. According to another aspect, portion 17a is mounted inside (a slot of) portion 17b by staking, in particular by heat staking. According to another aspect of the instant disclosure, portion 17a is mounted inside (a slot of) portion 17b by interference fit.

[0056] It is envisaged that at least one of the portions 17a and 17b is manufactured via an additive manufacturing technique such as three-dimensional printing. It is also envisaged that each of the portions 17a, 17b is manufactured via an additive manufacturing technique such as three-dimensional printing.

[0057] Now referring to FIG 4, a valve member 4 is shown with no segment on the inside of a bent. That is, the length of that segment m is zero. The fluid flow portion 6b then becomes a recess in the solid portion 5 of valve member 4.

[0058] The flow portion 6b of valve member 4 still provides a profile in a plane perpendicular to its pivot axis 10 with an arcuate segment 8b. The arcuate segment 8b as shown on FIG 4 also provides a first end and a second end sitting opposite the first end. The length dimension *n* of arcuate segment 8b is the length of a path *q* between the first end and the second end of arcuate segment 8b.

The length dimension *n* of arcuate segment 8b thus is the curve integral between the first end and the second end along a suitably parametrised path *q* of arcuate segment 8b:

$$n = \int_{\text{first end}}^{\text{second end}} 1 \cdot \mathrm{dq}.$$

[0059] According to an aspect, the arcuate segment 8b as shown on FIG 4 has a length dimension *n* of at least 3 mm, preferably of at least 7 mm or even 12 mm. It is also envisaged that the arcuate segment 8b has a length dimension of at least one eighths of the (spherical) diameter of the (ball-type) valve member 4, preferably of at least one fourth of the (spherical) diameter of the (ball-type) valve member 4 or even of at least one third the (spherical) diameter of the (ball-type) valve member 4.

[0060] As described in detail herein, the instant disclosure teaches a valve 1, the valve 1 comprising:

a valve body having an inlet conduit 2, an outlet conduit 3, and a fluid path extending between the inlet conduit 2 and the outlet conduit 3;
the valve 1 further comprising a valve member 4 situated in the fluid path between the inlet conduit 2 and the outlet conduit 3;
wherein the valve member 4 comprises a solid portion 5 and a first port 7a and a second port 7b and a fluid flow portion 6a; 6b extending between the first port 7a and the second port 7b;
wherein the valve 1 comprises a valve stem 9 anchored to the solid portion 5 of the valve member 4, the valve stem 9 defining a pivot axis 10;
wherein the valve stem 9 is configured to selectively pivot the valve member 4 about the pivot axis 10 defined by the valve stem 9 to a closed position which closes the fluid path between the inlet conduit 2 and the outlet conduit 3 and to an open position which opens the fluid path between the inlet conduit 2 and the outlet conduit 3;
wherein the fluid flow portion 6a; 6b has a profile in a plane perpendicular to the pivot axis 10;
wherein the profile of the fluid flow portion 6a; 6b comprises an arcuate segment 8a; 8b; and
wherein a pivotal movement of the valve member 4 by 180° about the pivot axis 10 and starting at the open position closes the fluid path.

[0061] In an embodiment, the valve stem 9 defines a plane perpendicular to the pivot axis 10.

[0062] It is envisaged that the arcuate segment 8a is a wall segment on the outside of a bent of the fluid flow portion 6a. The profile also provides a wall segment 18 on the inside of the bent of the fluid flow portion 6a. The former wall segment 8a and the latter wall segment 18 sit on opposite sides of the fluid flow portion 6a.

[0063] The arcuate segment 8a on the outside of the bent advantageously is perpendicular to the pivot axis 10. That is, any line connecting any two points along the arcuate segment 8a is perpendicular to the pivot axis 10.

[0064] According to an aspect, the solid portion 5 of the valve member 4 is a body portion of the valve member 4.

[0065] It is envisaged that a pivotal movement of the valve member 4 about the pivot axis 10 and starting at the open position by 180° closes, preferably always closes, the fluid path.

[0066] It is also envisaged that a pivotal movement of the valve member 4 about the pivot axis 10 and starting at the open position by 180° moves, preferably always moves, the valve member 4 to the closed position.

[0067] The instant disclosure also teaches any of the aforementioned valves 1,

wherein the fluid flow portion 6a; 6b defines a path of (laminar) fluid flow from the first port 7a to the second port 7b; and
wherein the pivot axis 10 is perpendicular or substantially perpendicular to the entire path of (laminar) fluid flow.

[0068] That is, any line connecting any two points along the path of fluid flow is perpendicular to the pivot axis 10.

[0069] The instant disclosure also teaches any of the aforementioned valves 1,

wherein the fluid flow portion 6a; 6b defines a path of (laminar) fluid flow from the first port 7a to the second port 7b; and
wherein the path of (laminar) fluid flow (lies in a and) defines a plane; and
wherein the pivot axis 10 is perpendicular or substantially perpendicular the plane defined by the path of (laminar) fluid flow.

[0070] The instant disclosure also teaches any of the aforementioned valves 1,
wherein the fluid flow portion is a recess in the solid portion 5 of the valve member 4.

[0071] The instant disclosure also teaches any of the aforementioned valves 1,
wherein the fluid flow portion is a conduit 14a, 14b, 14c perforating the solid portion 5 of the valve member 4.

[0072] The instant disclosure also teaches any of the aforementioned valves 1,

wherein the fluid flow portion comprises a first cylindrical conduit 14a and a second cylindrical conduit 14b and a knee conduit 14c, the knee conduit 14c having a profile in a plane perpendicular to the pivot axis 10 and the profile of the knee conduit 14c comprising the arcuate segment 8a; and
wherein the knee conduit 14c is interposed between the first cylindrical conduit 14a and the second cylindrical conduit 14b.

[0073] The instant disclosure also teaches any of the aforementioned valves 1,

wherein the first cylindrical conduit 14a defines a flow axis of the first cylindrical conduit 14a;
wherein the first cylindrical conduit 14a has first end and a second end and a length dimension between the first end of the first cylindrical conduit 14a and the second end of the first cylindrical conduit 14a, the length dimension of the first cylindrical conduit 14a extending along the flow axis of the first cylindrical conduit 14a;
wherein the length dimension of the first cylindrical conduit 14a exceeds 2 mm;
wherein the second cylindrical conduit 14b defines a flow axis of the second cylindrical conduit 14b;
wherein the second cylindrical conduit 14b has first end and a second end and a length dimension between the first end of the second cylindrical conduit 14b and the second end of the second cylindrical conduit 14b, the length dimension of the second cylindrical conduit 14b extending along to the flow axis of the second cylindrical conduit 14b; and
wherein the length dimension of the second cylindrical conduit 14b exceeds 2 mm.

[0074] It is also envisaged that the length dimension of the first cylindrical conduit 14a exceeds 5 mm or exceeds 10 mm. It is further envisaged that the length dimension of the second cylindrical conduit 14b exceeds 5 mm or exceeds 10 mm. Long cylindrical conduits 14a, 14b confer advantages in terms of more laminar flow.

[0075] The knee conduit 14c advantageously is disposed adjacent the first cylindrical conduit 14a. The knee conduit 14c advantageously is also disposed adjacent the second cylindrical conduit 14b.

[0076] The knee conduit 14c is preferably in fluid communication with the first cylindrical conduit 14a. The knee conduit 14c is preferably also in fluid communication with the second cylindrical conduit 14b.

[0077] In the open position, the first cylindrical conduit 14a cooperates with the inlet conduit 2 to enable fluid communication between the first cylindrical conduit 14a and the inlet conduit 2. In the open position, the second cylindrical conduit 14b also cooperates with the outlet conduit 3 to enable fluid communication between the second cylindrical conduit 14b and the outlet conduit 3.

[0078] The instant disclosure also teaches any of the aforementioned valves 1,

wherein the valve member 4 is a ball-type valve member;
wherein the valve member 4 has a centre 15, the centre 15 being a geometrical centre of the valve member 4;
wherein the arcuate segment 8a; 8b defines a bisecting axis 19 through the centre 15; and
wherein the arcuate segment 8a; 8b exhibits reflection symmetry about the bisecting axis 19.

[0079] The instant disclosure also teaches any of the aforementioned valves 1,

wherein the valve member 4 has an outer surface; and
wherein the centre 15 is disposed equidistant from or substantially equidistant from any point on the surface of the valve member 4.

[0080] The outer surface of the valve member 4 envelopes the valve member 4. The outer surface comprises a plurality of points.

[0081] The instant disclosure also teaches any of the aforementioned valves 1,
wherein the arcuate segment 8a; 8b is perpendicular to the pivot axis 10.

[0082] That is, any line connecting any two points of the arcuate segment 8a; 8b is perpendicular to the pivot axis 10.

[0083] The instant disclosure also teaches any of the aforementioned valves 1,
wherein the arcuate segment 8a; 8b has a first side facing the fluid flow portion 6a; 6b of the valve member 5 and a second side facing the solid portion 5 of the valve member 4.

[0084] The instant disclosure also teaches any of the aforementioned valves 1,

wherein the arcuate segment 8a; 8b has a first end and a second end, the second end being disposed opposite the first end, and an arc length dimension between the first end and the second end; and
wherein the arc length dimension is at least 2 mm.

[0085] The arc length dimension advantageously is at least 2 mm long, preferably at least 5 mm long or even at least 10 mm long.

[0086] The instant disclosure also teaches any of the aforementioned valves 1,

wherein the arcuate segment 8a; 8b has a first end and a second end, the second end being disposed opposite the first end, and an arc length dimension between the first end and the second end; and
wherein the valve member 4 has a diameter dimension 11; and
wherein the arc length dimension is at least one fifth of the diameter dimension 11 of the valve member 4.

[0087] The diameter dimension 11 in an embodiment with a ball-type valve member is the largest diameter dimension between opposite ends (on the spherical envelope of) the ball-type valve member 4.

[0088] According to an aspect, the valve member 4 substantially has spherical symmetry or even has spherical symmetry. The valve member 4 preferably is a ball-

type valve member 4.

[0089] It is envisaged that the solid portion 5 has a diameter dimension 11 and that the arc length dimension is at least one fifth of the diameter dimension 11 of the solid portion 5.

[0090] In an embodiment, the arc length dimension is at least one third of the diameter dimension 11 of the valve member 4, preferably at least one half of the diameter dimension 11 of the valve member 4 or even at least two-thirds of the diameter dimension 11 of the valve member 4.

[0091] The instant disclosure also teaches any of the aforementioned valves 1,

wherein the arcuate segment 8a; 8b has a first end and a second end, the second end sitting opposite the first end, the arcuate segment 8a; 8b defining a first axis 12a perpendicular to the arcuate segment 8a; 8b at the first end of the arcuate segment 8a; 8b; the arcuate segment 8a; 8b defining a second axis 12b perpendicular to the arcuate segment 8a; 8b at the second end of the arcuate segment 8a; 8b;
wherein the first axis 12a and the second axis 12b define an arc angle 13; and
wherein the arc angle 13 is at least 60°.

[0092] The arc angle 13 advantageously is at least 60°, preferably at least 70° or even at least 80°. According to an aspect, the first axis and the second axis are radial axes.

[0093] The instant disclosure also teaches any of the aforementioned valves 1,

wherein the outer surface of the valve member 4 comprises a shutter surface 20;
wherein, in the closed position, the shutter surface 20 faces at least one valve port, the at least one port being selected from the inlet conduit 2 or the outlet conduit 3 such that the shutter surface 20 obstructs fluid flow into and out of the at least one valve port and such that the fluid path 6a; 6b between the inlet conduit 2 and the outlet conduit 3 is closed.

[0094] The instant disclosure also teaches a multi-way valve comprising at least one valve 1 according to the instant disclosure.

[0095] It should be understood that the foregoing relates only to certain embodiments of the disclosure and that numerous changes may be made therein without departing from the scope of the disclosure as defined by the following claims. It should also be understood that the disclosure is not restricted to the illustrated embodiments and that various modifications can be made within the scope of the following claims.

Reference numerals

[0096]

1 valve
2 inlet conduit
3 outlet conduit
4 valve member
5 solid portion
6a, 6b fluid flow portion
7a first port
7b second port
8a, 8b arcuate segment
9 valve stem
10 pivot axis
11 diameter dimension
12a, 12b axes perpendicular to the arcuate segment
13 arc angle
14a, 14b cylindrical conduits
14c knee conduit
15 centre of the valve member 4
16 valve body
17a, 17b separable portions of valve member 4
18 segment on the inside of the bent
19 bisecting axis
20 shutter surface
21a, 21b flow axes

Claims

1. A valve (1), the valve (1) comprising:

a valve body having an inlet conduit (2), an outlet conduit (3), and a fluid path extending between the inlet conduit (2) and the outlet conduit (3);
the valve (1) further comprising a valve member (4) situated in the fluid path between the inlet conduit (2) and the outlet conduit (3);
wherein the valve member (4) comprises a solid portion (5) and a first port (7a) and a second port (7b) and a fluid flow portion (6a; 6b) extending between the first port (7a) and the second port (7b);
wherein the valve (1) comprises a valve stem (9) anchored to the solid portion (5) of the valve member (4), the valve stem (9) defining a pivot axis (10);
wherein the valve stem (9) is configured to selectively pivot the valve member (4) about the pivot axis (10) defined by the valve stem (9) to a closed position which closes the fluid path between the inlet conduit (2) and the outlet conduit (3) and to an open position which opens the fluid path between the inlet conduit (2) and the outlet conduit (3);
wherein the fluid flow portion (6a; 6b) has a profile in a plane perpendicular to the pivot axis (10);
wherein the profile of the fluid flow portion (6a; 6b) comprises an arcuate segment (8a; 8b);
wherein the inlet conduit (2) defines an inlet flow axis (21a) of fluid flow directly into the fluid flow

portion (6a; 6b) and the outlet conduit (3) defines an outlet flow axis (21b) of fluid flow directly from the fluid flow portion (6a; 6b);
wherein the pivot axis (10) is perpendicular to at least one of the inlet flow axis (21a) or the outlet flow axis (21b);
characterized in that
the fluid flow portion comprises a first cylindrical conduit (14a) and a second cylindrical conduit (14b) and a knee conduit (14c), the knee conduit (14c) having a profile in a plane perpendicular to the pivot axis (10) and the profile of the knee conduit (14c) comprising the arcuate segment (8a); and **in that**
the knee conduit (14c) is interposed between the first cylindrical conduit (14a) and the second cylindrical conduit (14b).

2. The valve (1) according to claim 1,

wherein a pivotal movement of the valve member (4) by 180° about the pivot axis (10) and starting at the open position closes the fluid path.

3. The valve (1) according to any of the claims 1 or 2,

wherein the fluid flow portion comprises a recess in the solid portion (5) of the valve member (4).

4. The valve (1) according to any of the claims 1 or 2,

wherein the fluid flow portion comprises a conduit (14a, 14b, 14c) perforating the solid portion (5) of the valve member (4).

5. The valve (1) according to any of the claims 1 to 4,

wherein the first cylindrical conduit (14a) defines a flow axis of the first cylindrical conduit (14a);
wherein the first cylindrical conduit (14a) has first end and a second end and a length dimension between the first end of the first cylindrical conduit (14a) and the second end of the first cylindrical conduit (14a), the length dimension of the first cylindrical conduit (14a) extending along the flow axis of the first cylindrical conduit (14a);
wherein the length dimension of the first cylindrical conduit (14a) exceeds 2 mm;
wherein the second cylindrical conduit (14b) defines a flow axis of the second cylindrical conduit (14b);
wherein the second cylindrical conduit (14b) has first end and a second end and a length dimension between the first end of the second cylindrical conduit (14b) and the second end of the second cylindrical conduit (14b), the length dimension of the second cylindrical conduit (14a) extending along the flow axis of the second cylindrical conduit (14b); and
wherein the length dimension of the second cylindrical conduit (14b) exceeds 2 mm.

6. The valve (1) according to any of the claims 1 to 5,

wherein the valve member (4) is a ball-type valve member;
wherein the valve member (4) has a centre (15), the centre (15) being a geometrical centre of the valve member (4);
wherein the arcuate segment (8a; 8b) defines a bisecting axis (19) through the centre (15); and
wherein the arcuate segment (8a; 8b) exhibits reflection symmetry about the bisecting axis (19).

7. The valve (1) according to any of the claims 1 to 6,

wherein the valve member (4) has an outer surface; and
wherein the centre (15) is disposed equidistant from or substantially equidistant from any point on the outer surface of the valve member (4).

8. The valve (1) according to any of the claims 1 to 7,

wherein the arcuate segment (8a; 8b) is perpendicular to the pivot axis (10).

9. The valve (1) according to any of the claims 1 to 8,

wherein the arcuate segment (8a; 8b) has a first side facing the fluid flow portion (6a; 6b) of the valve member (5) and a second side facing the solid portion (5) of the valve member (4).

10. The valve (1) according to any of the claims 1 to 9,

wherein a pivotal movement of the valve member (4) about the pivot axis (10) and starting at the open position by 180° always closes the fluid path.

11. The valve (1) according to any of the claims 1 to 10,

wherein the arcuate segment (8a; 8b) has a first end and a second end, the second end being disposed opposite the first end, and an arc length dimension between the first end and the second end; and
wherein the arc length dimension is at least 2 mm.

12. The valve (1) according to any of the claims 1 to 11,

wherein the arcuate segment (8a; 8b) has a first end and a second end, the second end being

disposed opposite the first end, and an arc length dimension between the first end and the second end; and
wherein the valve member (4) has a diameter dimension (11); and
wherein the arc length dimension is at least one fifth of the diameter dimension (11) of the valve member (4).

13. The valve (1) according to any of the claims 1 to 12,

wherein the arcuate segment (8a; 8b) has a first end and a second end, the second end sitting opposite the first end, the arcuate segment (8a; 8b) defining a first axis (12a) perpendicular to the arcuate segment (8a; 8b) at the first end of the arcuate segment (8a; 8b); the arcuate segment (8a; 8b) defining a second axis (12b) perpendicular to the arcuate segment (8a; 8b) at the second end of the arcuate segment (8a; 8b);
wherein the first axis (12a) and the second axis (12b) define an arc angle (13); and
wherein the arc angle (13) is at least 60°.

14. The valve (1) according to any of the claims 1 to 13,

wherein the outer surface of the valve member (4) comprises a shutter surface (20);
wherein, in the closed position, the shutter surface (20) faces at least one valve port, the at least one port being selected from the inlet conduit (2) or the outlet conduit (3) such that the shutter surface (20) obstructs fluid flow into and out of the at least one valve port and
such that the fluid path (6a; 6b) between the inlet conduit (2) and the outlet (3) conduit is closed.

15. The valve (1) according to any of the claims 1 to 14, wherein the fluid flow portion (6a; 6b) defines a path of fluid flow from the first port (7a) to the second port (7b); and wherein the pivot axis (10) is perpendicular to the entire path of fluid flow.

Amended claims in accordance with Rule 137(2) EPC.

1. A valve (1), the valve (1) comprising:

a valve body having an inlet conduit (2), an outlet conduit (3), and a fluid path extending between the inlet conduit (2) and the outlet conduit (3);
the valve (1) further comprising a valve member (4) situated in the fluid path between the inlet conduit (2) and the outlet conduit (3);
wherein the valve member (4) comprises a solid portion (5) and a first port (7a) and a second port (7b) and a fluid flow portion (6a; 6b) extending between the first port (7a) and the second port (7b);
wherein the valve (1) comprises a valve stem (9) anchored to the solid portion (5) of the valve member (4), the valve stem (9) defining a pivot axis (10);
wherein the valve stem (9) is configured to selectively pivot the valve member (4) about the pivot axis (10) defined by the valve stem (9) to a closed position which closes the fluid path between the inlet conduit (2) and the outlet conduit (3) and to an open position which opens the fluid path between the inlet conduit (2) and the outlet conduit (3);
wherein the fluid flow portion (6a; 6b) has a profile in a plane perpendicular to the pivot axis (10);
wherein the profile of the fluid flow portion (6a; 6b) comprises an arcuate segment (8a; 8b);
wherein the inlet conduit (2) defines an inlet flow axis (21a) of fluid flow directly into the fluid flow portion (6a; 6b) and the outlet conduit (3) defines an outlet flow axis (21b) of fluid flow directly from the fluid flow portion (6a; 6b);
wherein the pivot axis (10) is perpendicular to at least one of the inlet flow axis (21a) or the outlet flow axis (21b);
characterized in that
the fluid flow portion comprises a first cylindrical conduit (14a) and a second cylindrical conduit (14b) and a knee conduit (14c), the knee conduit (14c) having a profile in a plane perpendicular to the pivot axis (10) and the profile of the knee conduit (14c) comprising the arcuate segment (8a); and **in that**
the knee conduit (14c) is interposed between the first cylindrical conduit (14a) and the second cylindrical conduit (14b).

2. The valve (1) according to claim 1,
wherein a pivotal movement of the valve member (4) by 180° about the pivot axis (10) and starting at the open position closes the fluid path.

3. The valve (1) according to any of the claims 1 or 2,
wherein the fluid flow portion comprises a conduit (14a, 14b, 14c) perforating the solid portion (5) of the valve member (4).

4. The valve (1) according to any of the claims 1 to 3,

wherein the first cylindrical conduit (14a) defines a flow axis of the first cylindrical conduit (14a);
wherein the first cylindrical conduit (14a) has first end and a second end and a length dimension between the first end of the first cylindrical conduit (14a) and the second end of the first cylindrical conduit (14a), the length dimension of the first cylindrical conduit (14a) extending along the

flow axis of the first cylindrical conduit (14a);
wherein the length dimension of the first cylindrical conduit (14a) exceeds 2 mm;
wherein the second cylindrical conduit (14b) defines a flow axis of the second cylindrical conduit (14b);
wherein the second cylindrical conduit (14b) has first end and a second end and a length dimension between the first end of the second cylindrical conduit (14b) and the second end of the second cylindrical conduit (14b), the length dimension of the second cylindrical conduit (14a) extending along the flow axis of the second cylindrical conduit (14b); and
wherein the length dimension of the second cylindrical conduit (14b) exceeds 2 mm.

5. The valve (1) according to any of the claims 1 to 4,

wherein the valve member (4) is a ball-type valve member;
wherein the valve member (4) has a centre (15), the centre (15) being a geometrical centre of the valve member (4);
wherein the arcuate segment (8a; 8b) defines a bisecting axis (19) through the centre (15); and
wherein the arcuate segment (8a; 8b) exhibits reflection symmetry about the bisecting axis (19).

6. The valve (1) according to any of the claims 1 to 5,

wherein the valve member (4) has an outer surface; and
wherein the centre (15) is disposed equidistant from or substantially equidistant from any point on the outer surface of the valve member (4).

7. The valve (1) according to any of the claims 1 to 6, wherein the arcuate segment (8a; 8b) is perpendicular to the pivot axis (10).

8. The valve (1) according to any of the claims 1 to 7, wherein the arcuate segment (8a; 8b) has a first side facing the fluid flow portion (6a; 6b) of the valve member (5) and a second side facing the solid portion (5) of the valve member (4).

9. The valve (1) according to any of the claims 1 to 8, wherein a pivotal movement of the valve member (4) about the pivot axis (10) and starting at the open position by 180° always closes the fluid path.

10. The valve (1) according to any of the claims 1 to 9,

wherein the arcuate segment (8a; 8b) has a first end and a second end, the second end being disposed opposite the first end, and an arc length dimension between the first end and the second end; and
wherein the arc length dimension is at least 2 mm.

11. The valve (1) according to any of the claims 1 to 10,

wherein the arcuate segment (8a; 8b) has a first end and a second end, the second end being disposed opposite the first end, and an arc length dimension between the first end and the second end; and
wherein the valve member (4) has a diameter dimension (11); and
wherein the arc length dimension is at least one fifth of the diameter dimension (11) of the valve member (4).

12. The valve (1) according to any of the claims 1 to 11,

wherein the arcuate segment (8a; 8b) has a first end and a second end, the second end sitting opposite the first end, the arcuate segment (8a; 8b) defining a first axis (12a) perpendicular to the arcuate segment (8a; 8b) at the first end of the arcuate segment (8a; 8b); the arcuate segment (8a; 8b) defining a second axis (12b) perpendicular to the arcuate segment (8a; 8b) at the second end of the arcuate segment (8a; 8b);
wherein the first axis (12a) and the second axis (12b) define an arc angle (13); and
wherein the arc angle (13) is at least 60°.

13. The valve (1) according to any of the claims 1 to 12,

wherein the outer surface of the valve member (4) comprises a shutter surface (20);
wherein, in the closed position, the shutter surface (20) faces at least one valve port, the at least one port being selected from the inlet conduit (2) or the outlet conduit (3) such that the shutter surface (20) obstructs fluid flow into and out of the at least one valve port and
such that the fluid path (6a; 6b) between the inlet conduit (2) and the outlet (3) conduit is closed.

14. The valve (1) according to any of the claims 1 to 13, wherein the fluid flow portion (6a; 6b) defines a path of fluid flow from the first port (7a) to the second port (7b); and wherein the pivot axis (10) is perpendicular to the entire path of fluid flow.

FIG 1

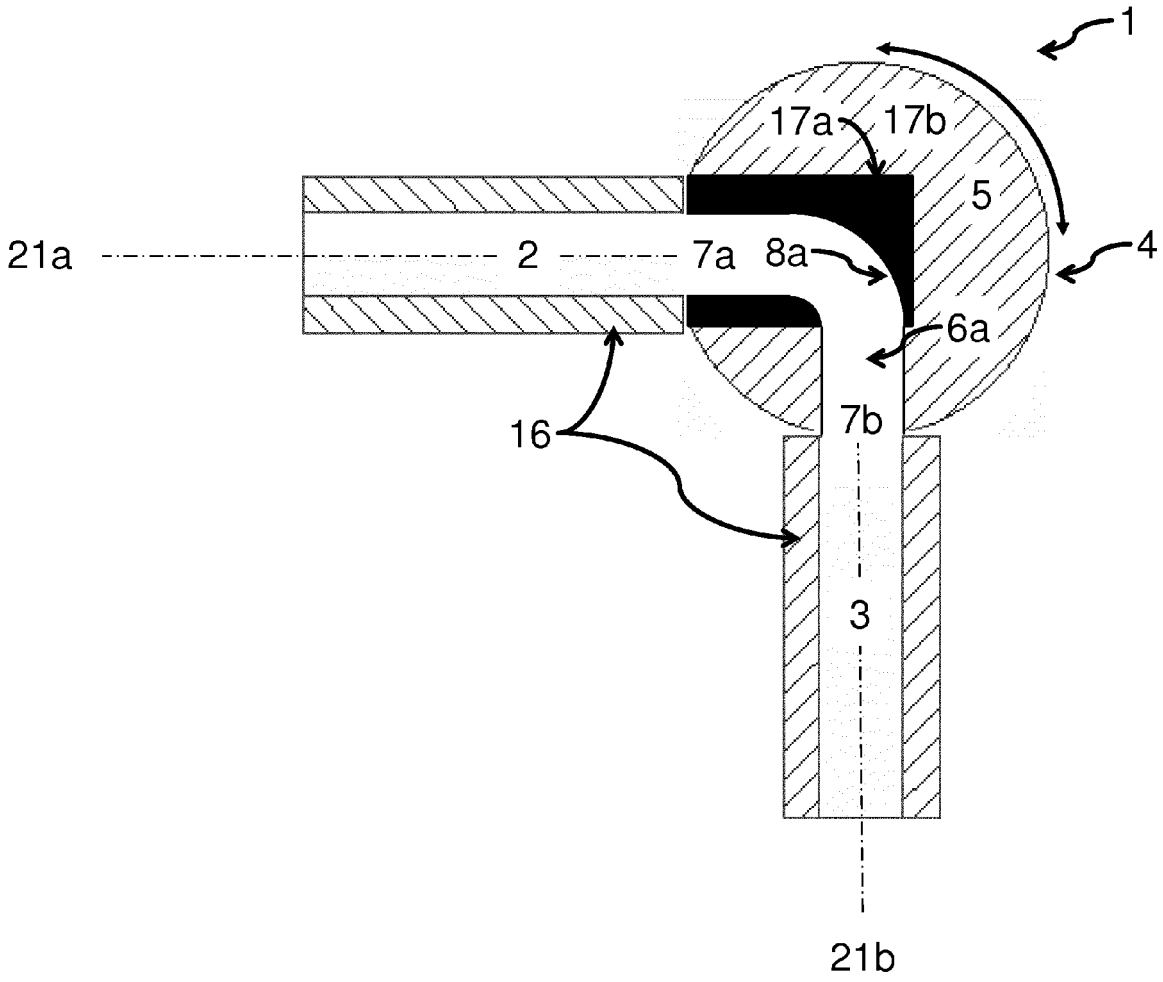


FIG 2

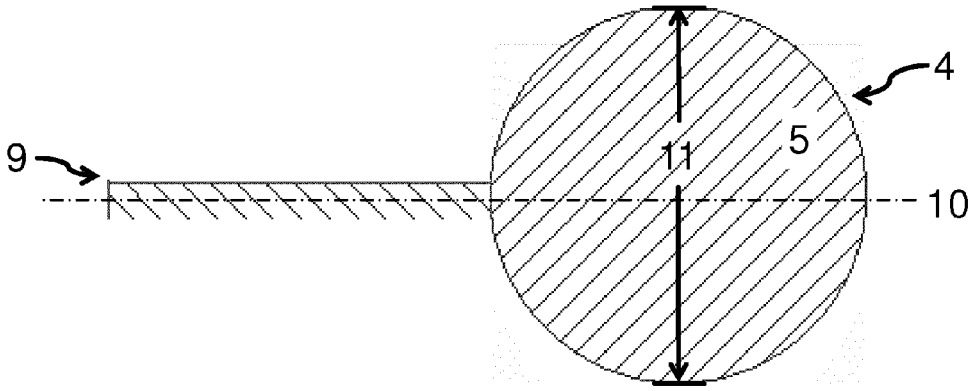


FIG 3

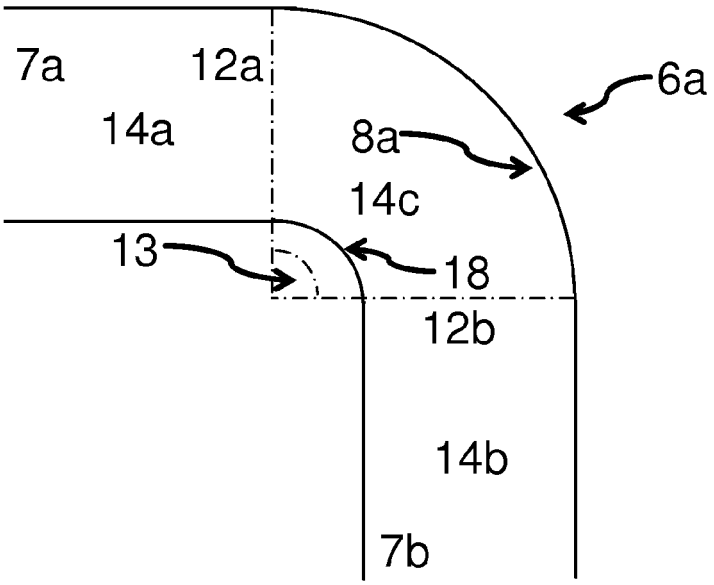
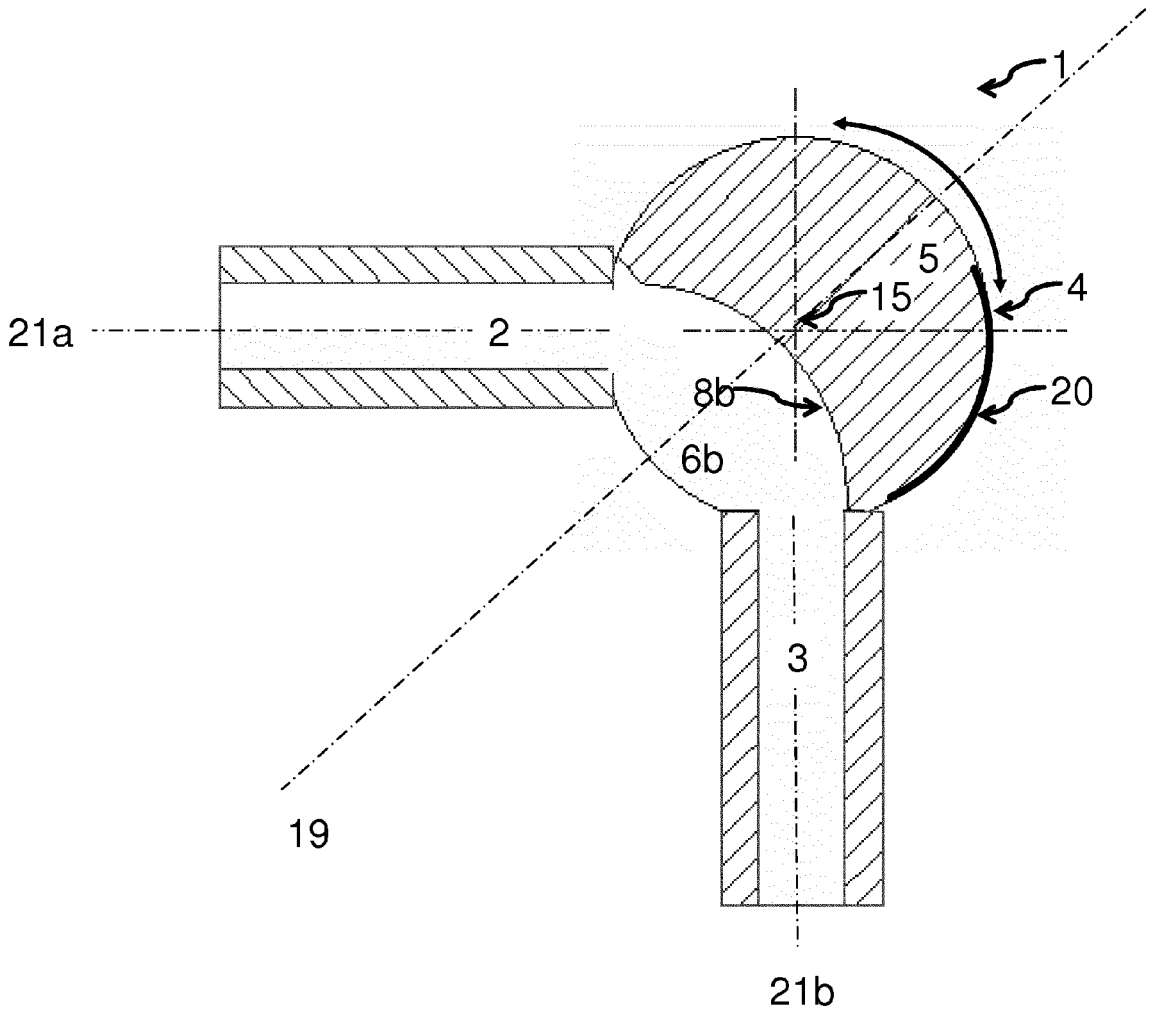


FIG 4



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EUROPEAN SEARCH REPORT

Application Number
EP 18 20 6501

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Place of search	Date of completion of the search	Examiner
The Hague	7 May 2019	Lanel, François

CATEGORY OF CITED DOCUMENTS

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